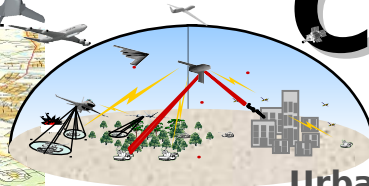
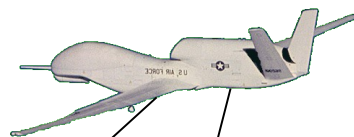




AFFRL

THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER



Sensor Challenges

19 April 2006



Dr. Paul McManamon
Chief Scientist, Sensors Directorate
Air Force Research Laboratory



Outline

- **AFRL Sensors Directorate Background**
- FLTCs and other Driving Forces for the Sensors Directorate
- Sensors Directorate Visions
- Summary

Sensors Directorate



Our Mission

To lead the discovery, development, and integration of affordable sensor and countermeasure technologies for our warfighters.

Our Vision

Robust sensors and adaptive countermeasures that guarantee complete freedom of air and space operations for our forces, and deny these capabilities to our adversaries at times and places of our choosing



Sensors Directorate

ORG. DEVELOPMENT
(SNN) DR. D. SASARAK 937-255-44515
CHIEF ENGINEER
MR. F. PAUL JOHNSON 937-255-65022

DIRECTOR
MR. J. SCIABICA 937-255-2620
DEPUTY DIRECTOR
COL G. HOPPER 937-255-2620
CHIEF SCIENTIST
DR. P. MCMANAMON 937-255-2620

INTEGRATION & OPERATIONS
(SNO) MR. D. TOMLINSON 937-255-6180
FINANCIAL MANAGEMENT
(SNF) MS. C. VAN VOORHIS 937-904-9291
CONTRACTING
(PKS) MS. D. SUCHECKI 937-255-0350
SECURITY
(SNY) MS. K. CATALANO 937-255-7208

**AEROSPACE
COMPONENTS
& SUBSYSTEMS
TECHNOLOGY**
(SND)
MR. T. KASTLE 937-255-2911

**ELECTROMAGNETIC
TECHNOLOGY**
(SNH)
DR. R. PAYNE 781-377-5129

**RF SENSOR
TECHNOLOGY**
(SNR)
MR. W. MOORE 937-255-5218

**EO SENSOR
TECHNOLOGY**
(SNJ)
COL R. GAUDETTE 937-255-4039

**AUTOMATIC
TARGET
RECOGNITION
(ATR) TECHNOLOGY**
(SNA)
DR. M. BRYANT 937-255-4949

**SIGNATURE
TECHNOLOGY
OFFICE**
(SNS)
MR. W. CUZICK 937-255-9175

**SENSOR APPLICATIONS
&
DEMONSTRATIONS**
(SNZ)
LT COL C. GILMOUR (Act'g)
937-255-5418

**ANTI-TAMPER -
SOFTWARE PROTECTION
INITIATIVE OFFICE**
(SNT)
MR. J. HUGHES 937-320-9068



Sensors Directorate Technology Thrusts



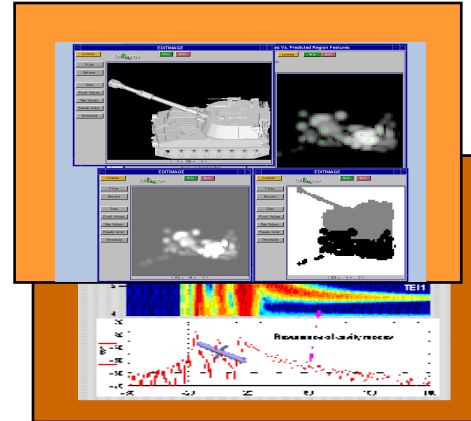
Radio Frequency Sensors & Countermeasures



Electro-Optical Sensors & Countermeasures



Automatic Target Recognition & Sensor Fusion



Application Sub-thrusts



- Battlespace Access
- Persistent ISR of the Battlespace
- Prosecution of Time Sensitive Targets



- Radio Frequency Aperture Transmitters & Receivers
- Algorithms & Phenomenology
- Digital Receivers & Exciter Phenomenology & Algorithms
- Reference Systems
- Components

- Signatures & Modeling
- Assessment & Foundation
- Innovative

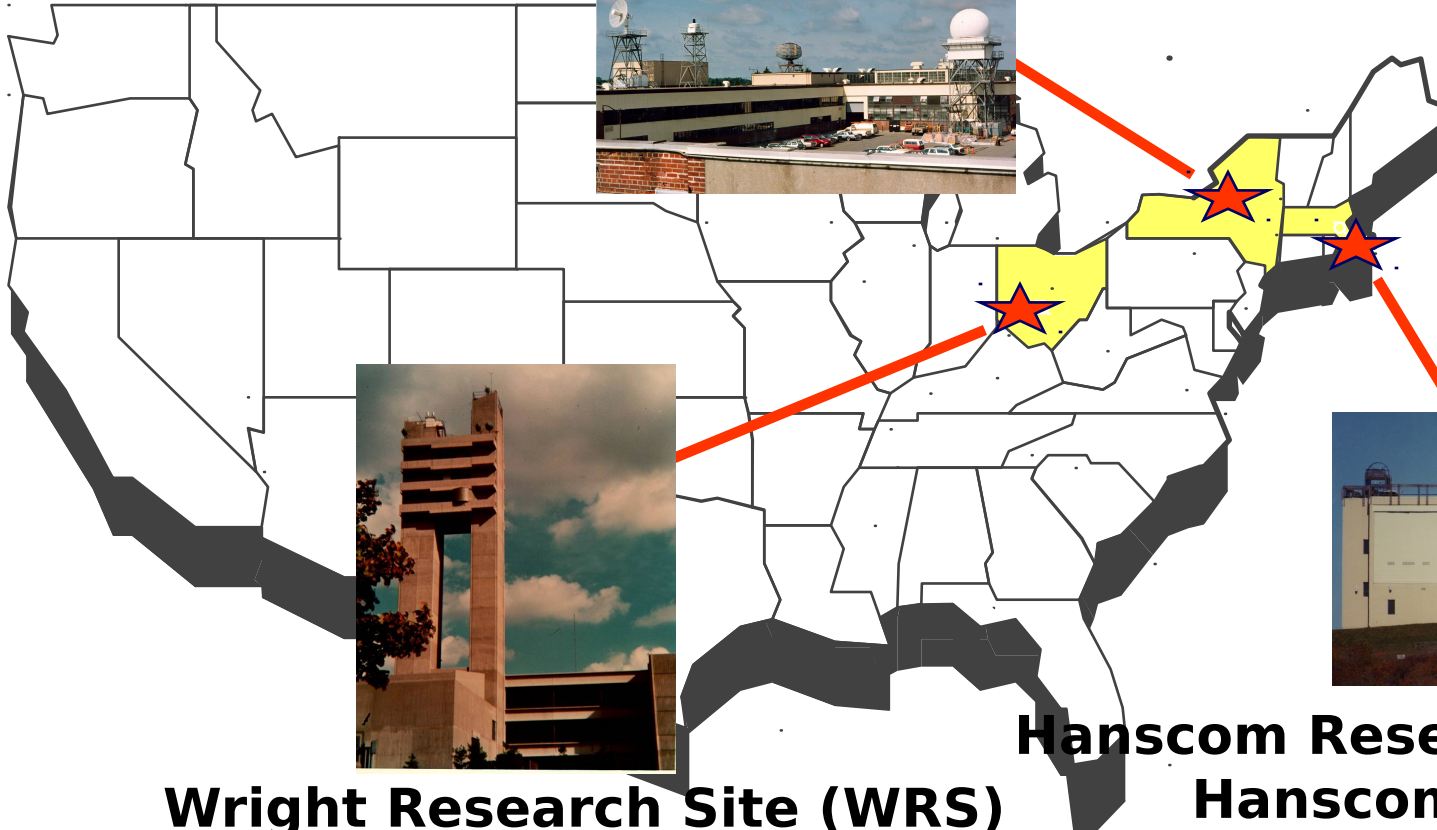
Enabling Sub-thrusts



Sensors Directorate Locations



Rome Research Site (RRS) Rome, NY



Wright Research Site (WRS) Wright-Patterson AFB, OH

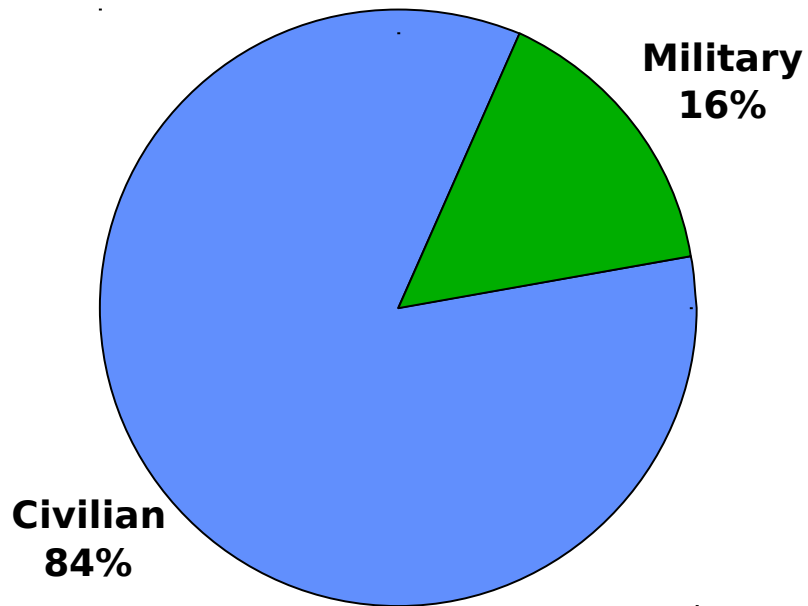


Hanscom Research Site (HRS) Hanscom AFB, MA

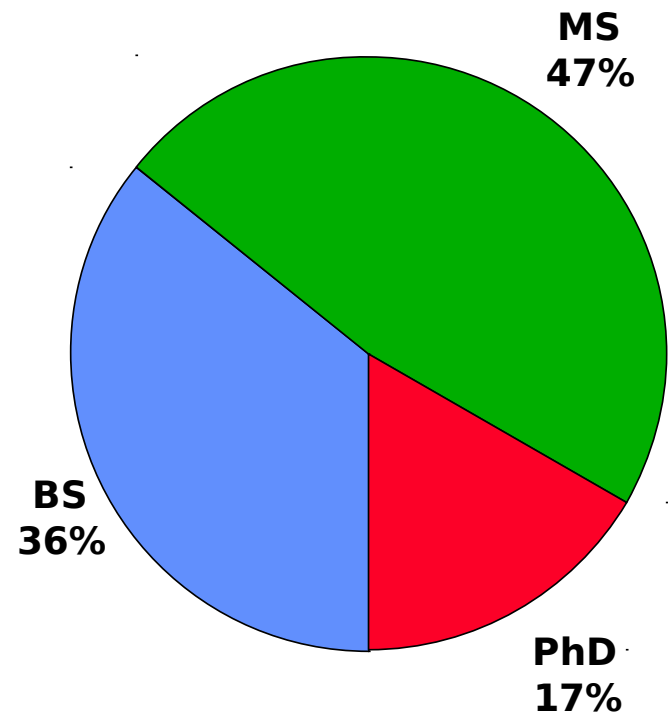


Personnel - Total All Sites

Government	753
IPAs	3
<u>On-Site Contractors</u>	<u>493</u>
Total	1249



Government (753)

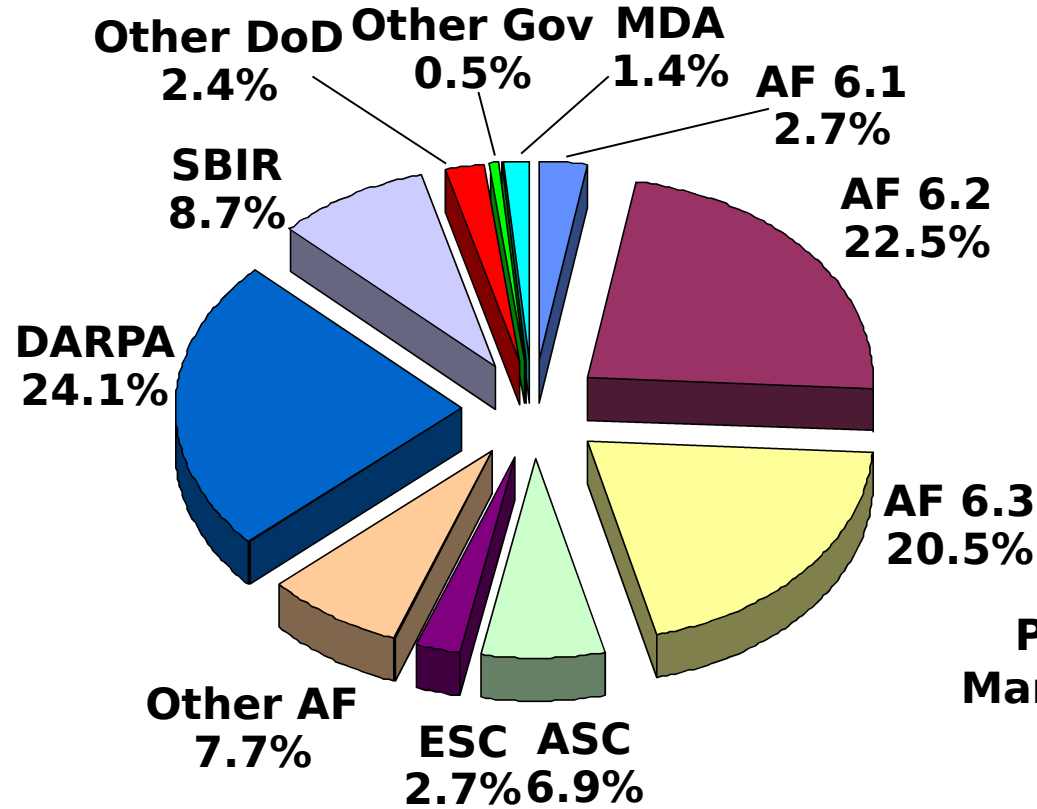


S&E (591)



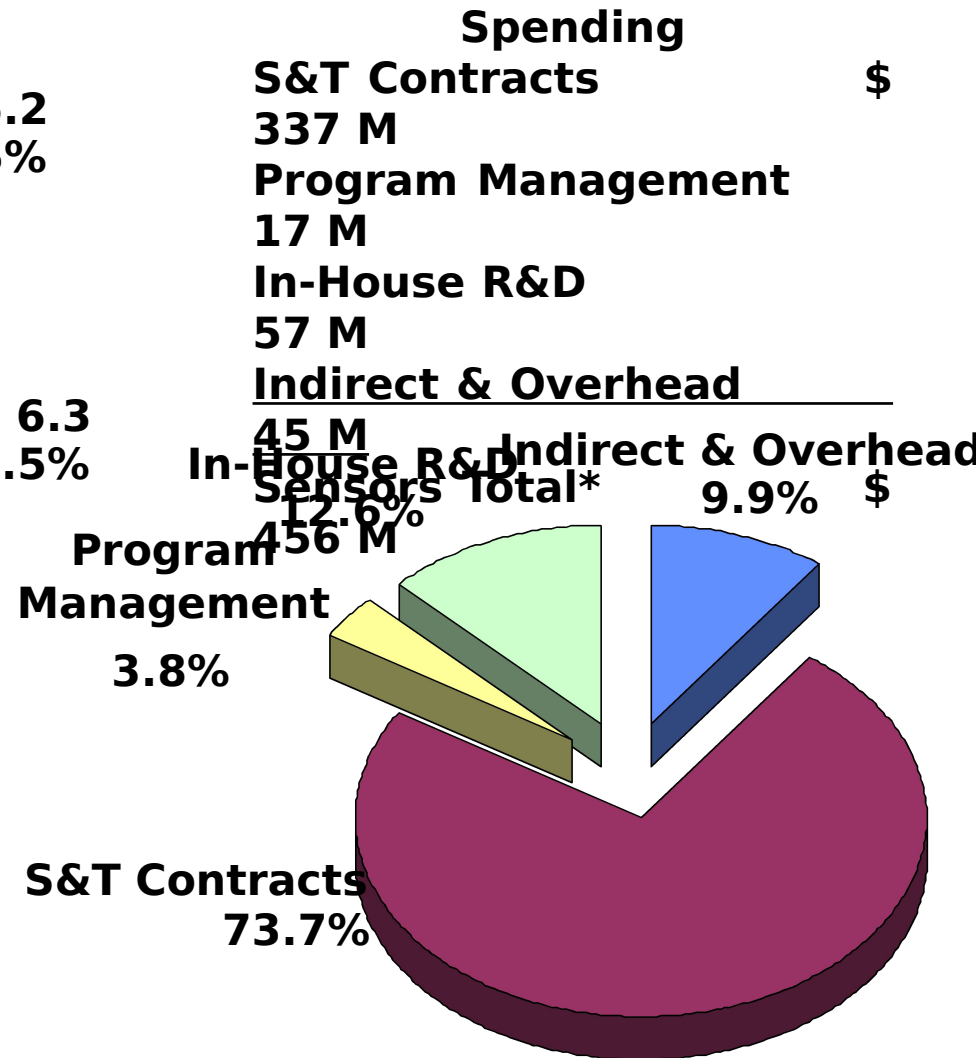
Sensors Directorate

FY05 Funding & Spending



Income

AF S&T	\$ 196 M
Other Sources	260 M
Sensors Total*	\$ 456 M





Outline

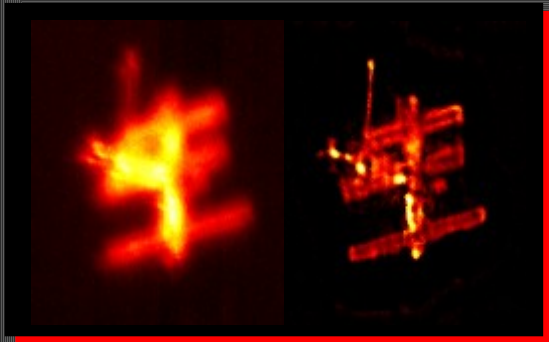
- AFRL Sensors Directorate background
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FLTC #2



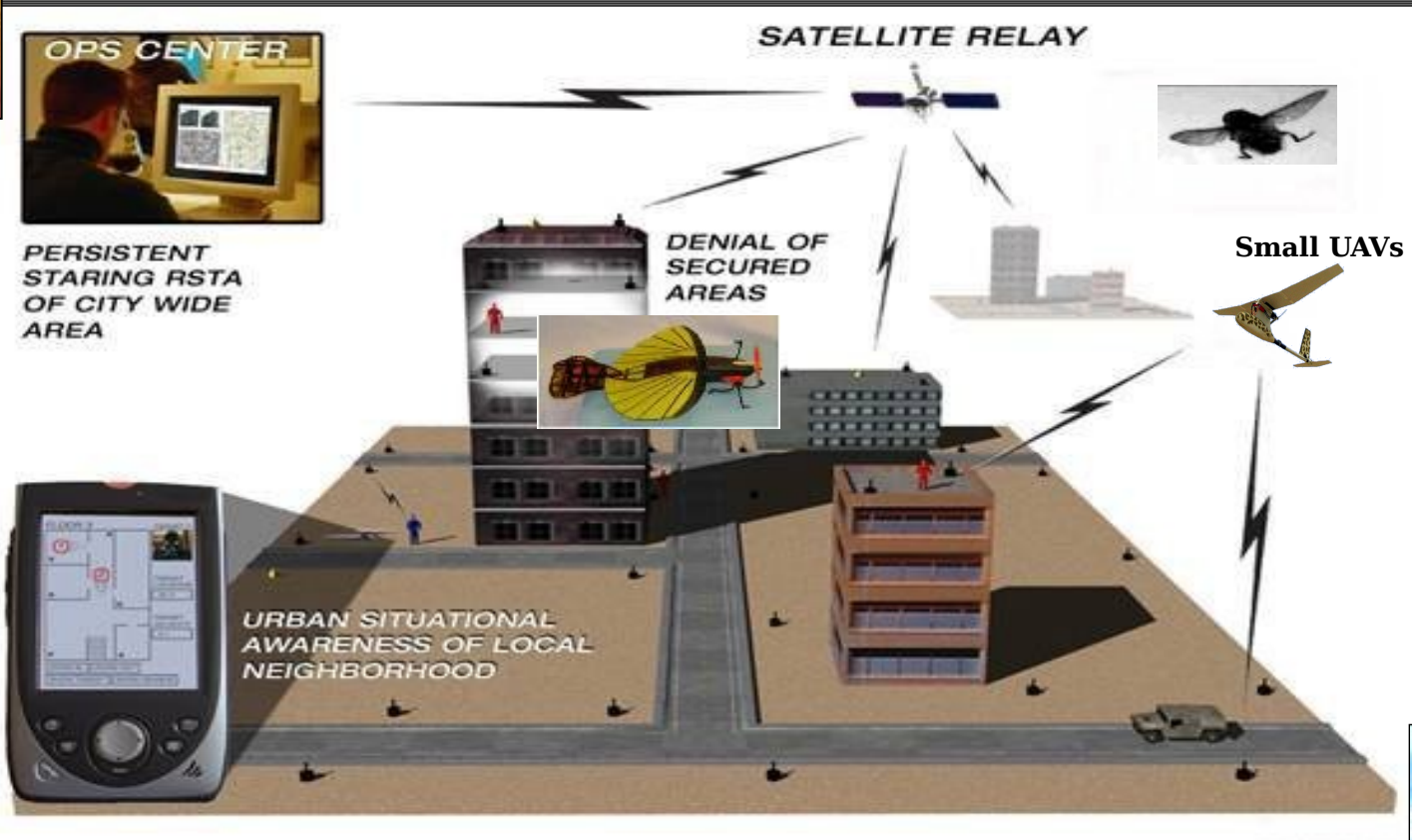
Proactively Find, Fix, and Track Anything, Anytime, Anywhere with Agile and Immediate C4ISR





FLTC #3

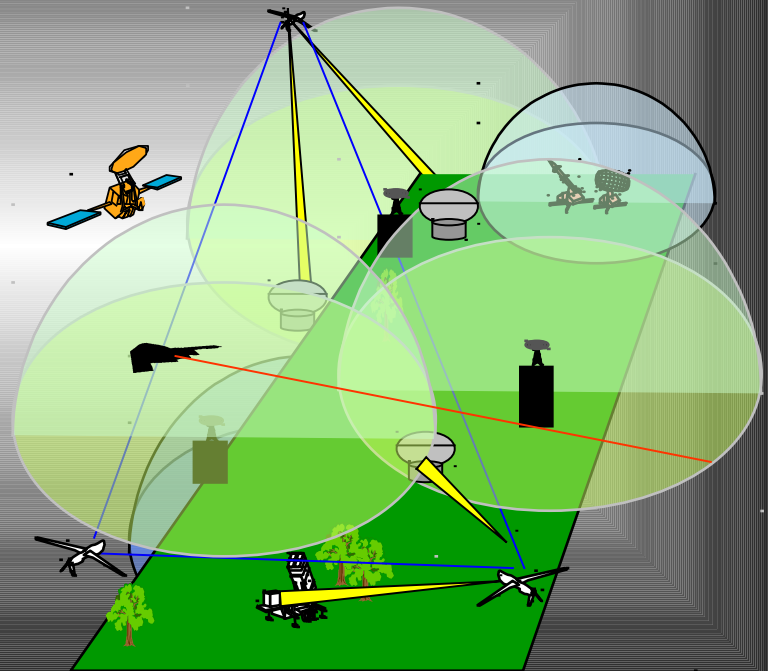
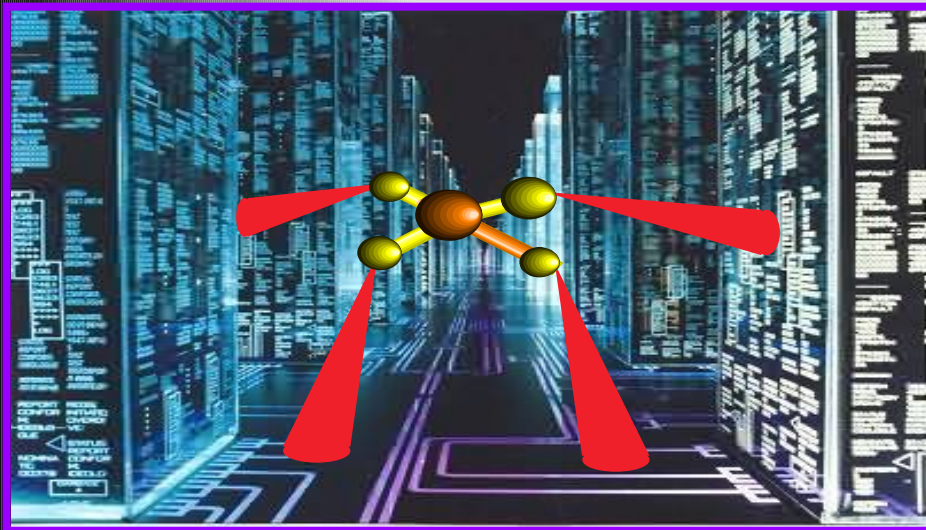
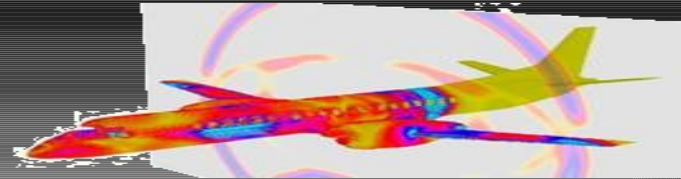
Detect, Tag, Track, Identify, Target Adversaries, IEDs, CBRNE in Congested or Concealed Environments and Create Desired Effects





FLTC #5

Achieve Mission Objectives With Impunity Against Full Spectrum Threats, from Anti-Access IADS to Cyber





DOD Level - Changing the Plot



- For decades the Pentagon's war plans focused on countering conventional military threats.
- New planning scenarios focus on preparing for a wider range of contingencies

IRREGULAR

Those seeking to erode U.S. influence and power by employing unconventional methods, such as:

- Terrorism
- Insurgency
- Civil war
- Emerging concepts such as "unrestricted warfare"

Likelihood: very high

Vulnerability: moderate, if not effectively checked



More likely

CATASTROPHIC

Those seeking to paralyze U.S. leadership and power by employing weapons of mass destruction or WMD-like effects in surprise attacks on symbolic, critical or other high-value targets, such as:

- Sept. 11, 2001
- Terrorist use of WMD
- Rogue missile attack

Likelihood: moderate and increasing

Vulnerability: unacceptable; single event could alter American way of life



Lower vulnerability

TRADITIONAL

Those seeking to challenge U.S. power by military operations, such as:

- Conventional air, sea and land attacks
- Nuclear forces of established nuclear powers

Likelihood: decreasing (absent pre-emption) due to historic capability-overmatch and expanding qualitative lead

Vulnerability: low, if transformation is balanced



Less likely

DISRUPTIVE

Those seeking to usurp U.S. power and influence by acquiring breakthrough capabilities, such as:

- Sensors
- Biotechnology
- Miniaturization on the molecular level
- Cyber-operations
- Space
- Directed-energy and other emerging fields

Likelihood: low, but time works against U.S.

Vulnerability: unknown; strategic surprise puts U.S. security at risk





Some 2005 QDR ISR Visions



- Establish an “unblinking eye” over the battlespace
- Integrate global awareness with local precision
- Support operations against any target, day or night, in any weather, and in denied or contested areas
- Develop responsive space. Improve SSA
- Integrate Space and Air - featuring denied area ops. Investigate the use of high-altitude loitering capabilities
- Increase measurement and signature intelligence (MASINT) to ID enemy WMD
- Increase investment in unmanned aerial vehicles to provide more flexible capabilities to identify and track moving targets in denied areas



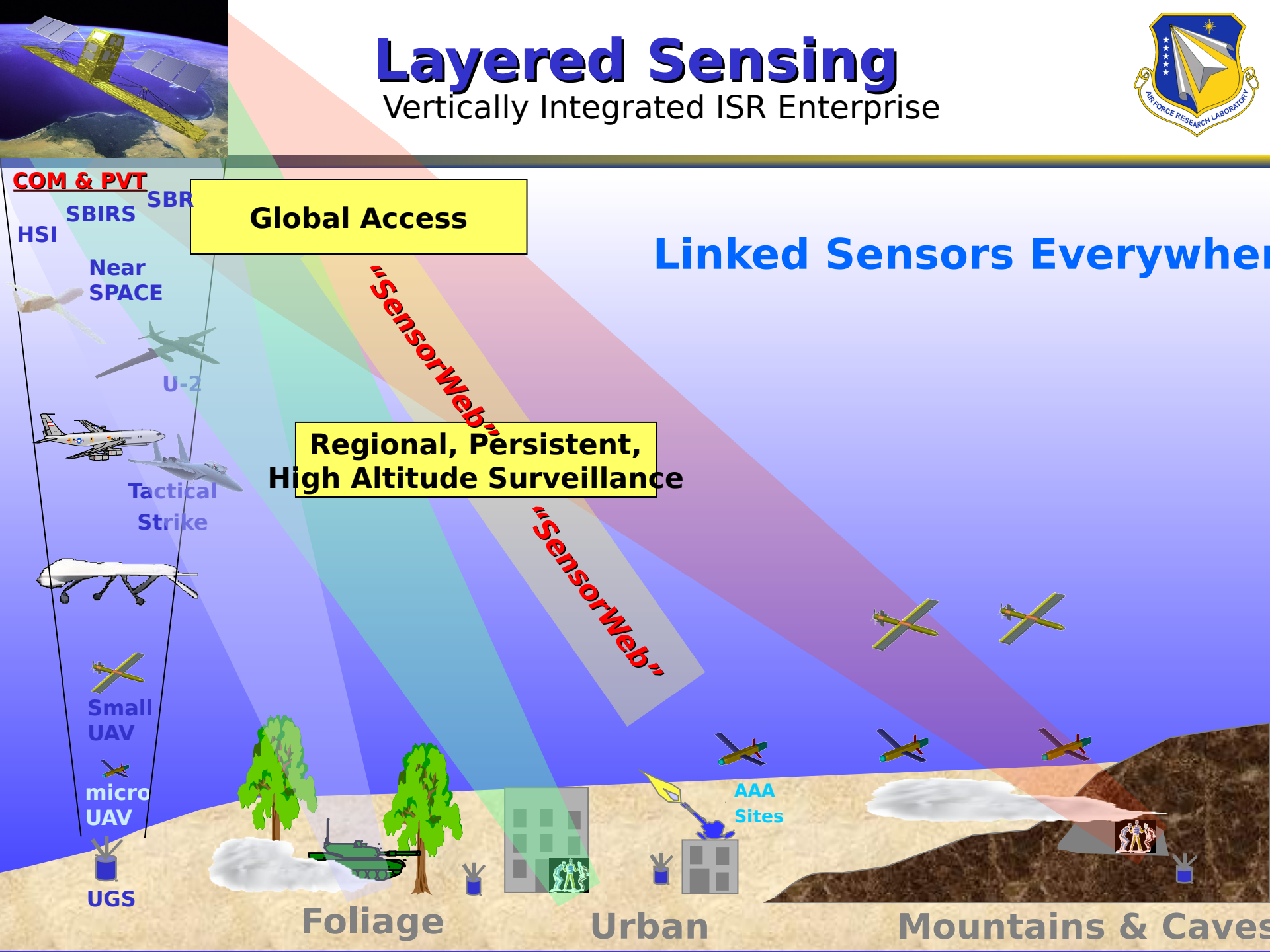
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Layered Sensing

Vertically Integrated ISR Enterprise



Global Access

Linked Sensors Everywhere

**Regional, Persistent,
High Altitude Surveillance**

"SensorWeb"

"SensorWeb"

COM & PVT

SBIRS

SBR

HSI

**Near
SPACE**

U-2

**Tactical
Strike**

**Small
UAV**

**micro
UAV**

UGS

**AAA
Sites**

Foliage

Urban

Mountains & Caves



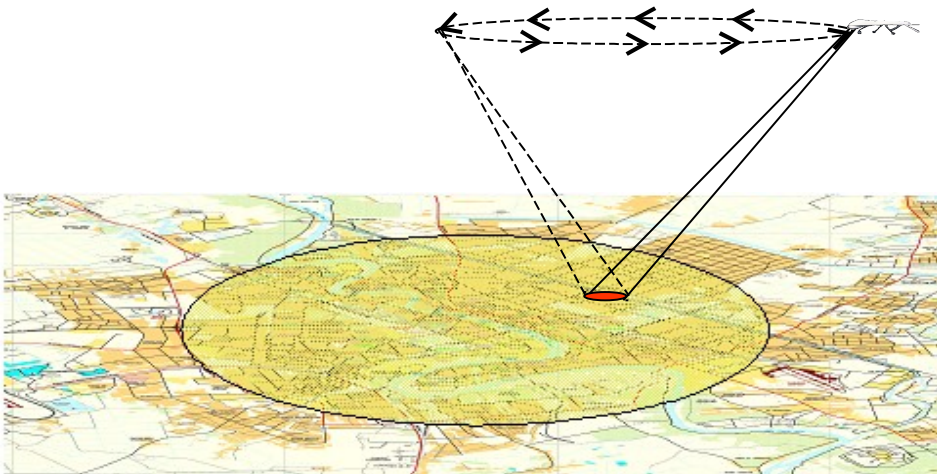
Continuous Surveillance



Know
everything all
of the time



Multi-sensor EO and SAR System
3D Pixel Registered



Gotcha Radar System

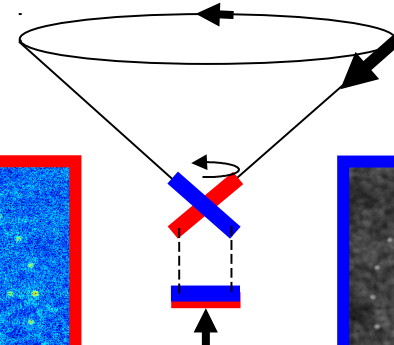
Persistent, High Altitude, All-Wx Surveillance



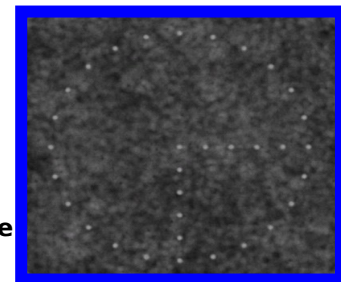
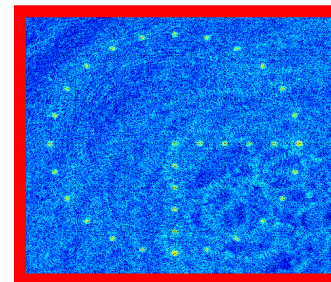
- **Continuous Track (Civilian Vehicles & Dismounts)**
- **High Resolution Imagery (Enable Target ID)**
- **Detect Hidden Targets (Inside Buildings)**
- **Behavior Analysis (Enable PBA)**
- **Forensic Backtracking**



SAR + EO



Art of the Possible
3D Registered
EO and SAR
From
Single EO and Single SAR
Aperture





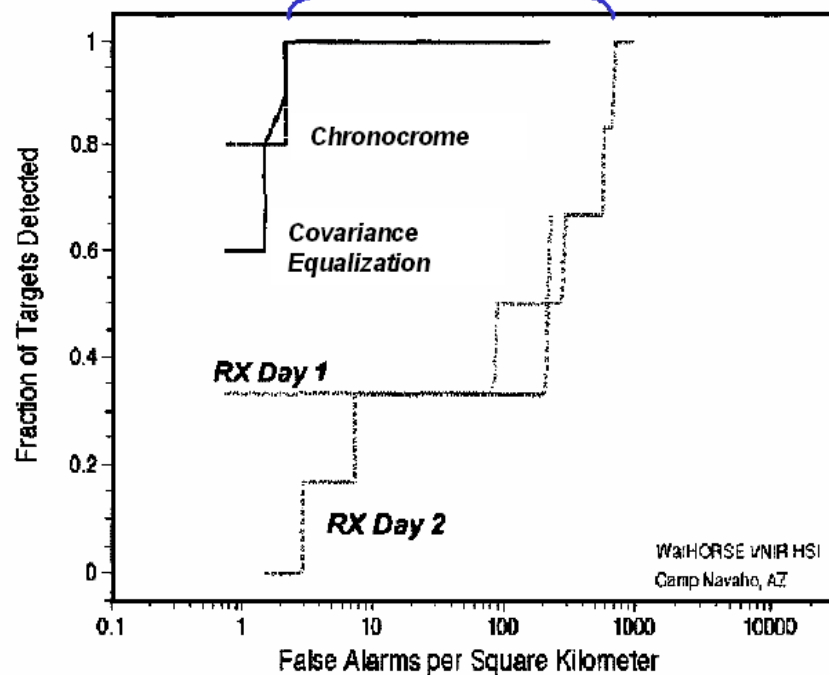
Multi-sensor Change Detection

Two Orders of Magnitude False Alarm Reduction With Change Detection

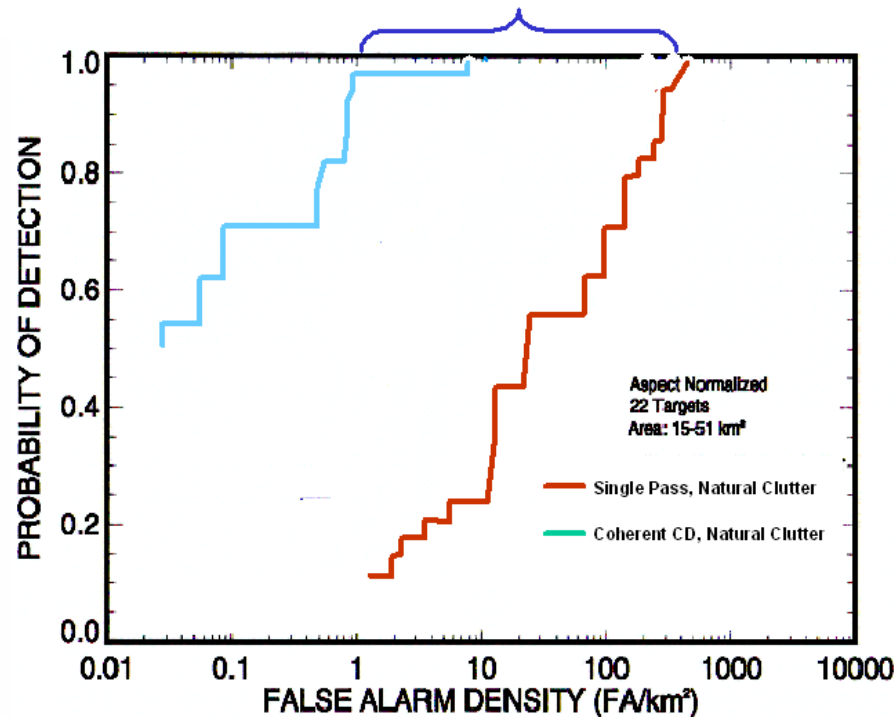
HSI

VHF SAR

Over 2 Orders of Magnitude



Over 2 Orders of Magnitude





Affordable High Bandwidth, Instant, Comm.

- High Bandwidth Lasercom through thick clouds
- Quantum communications through water and earth
- Cheap comm. to all sorts of vehicles





Pro-Active Countermeasures / Threat Suppression

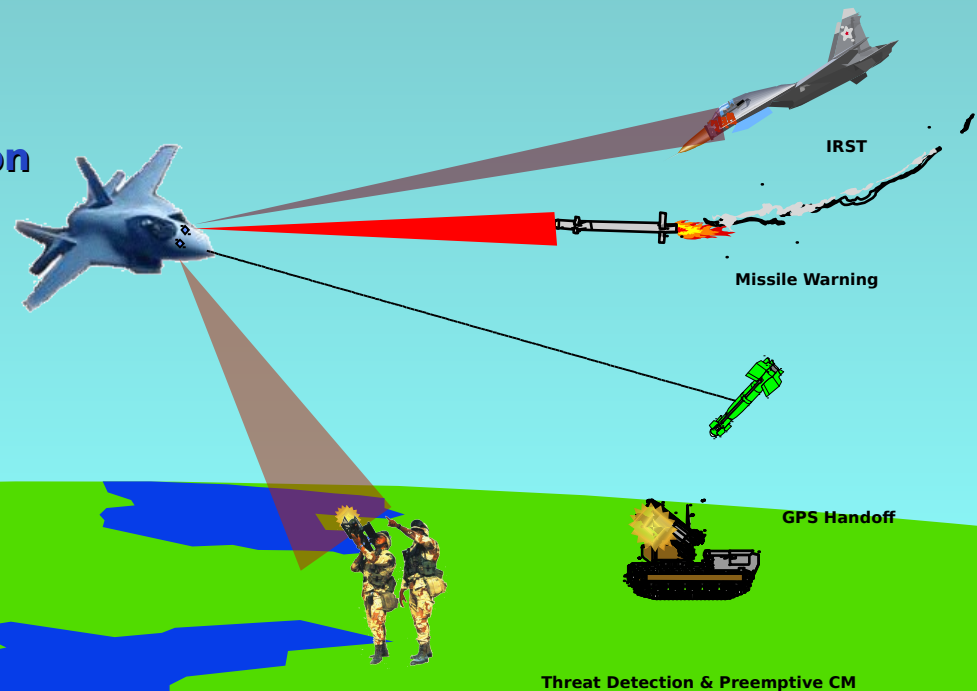


- EO/RF Conformal, phased array Apertures
- Destroy all threats (the van - with the operators)
- **Prefer speed of light, cheap, threat destruction**

Impervious countermeasures

INTEGRATION FACTORS

- Large angular coverage (multiple apertures)
- Wide area surveillance & high resolution sensing
- Conformal LO aperture combining passive & active elements
- Compact LRUs sized to replace current Missile Warning Sensors

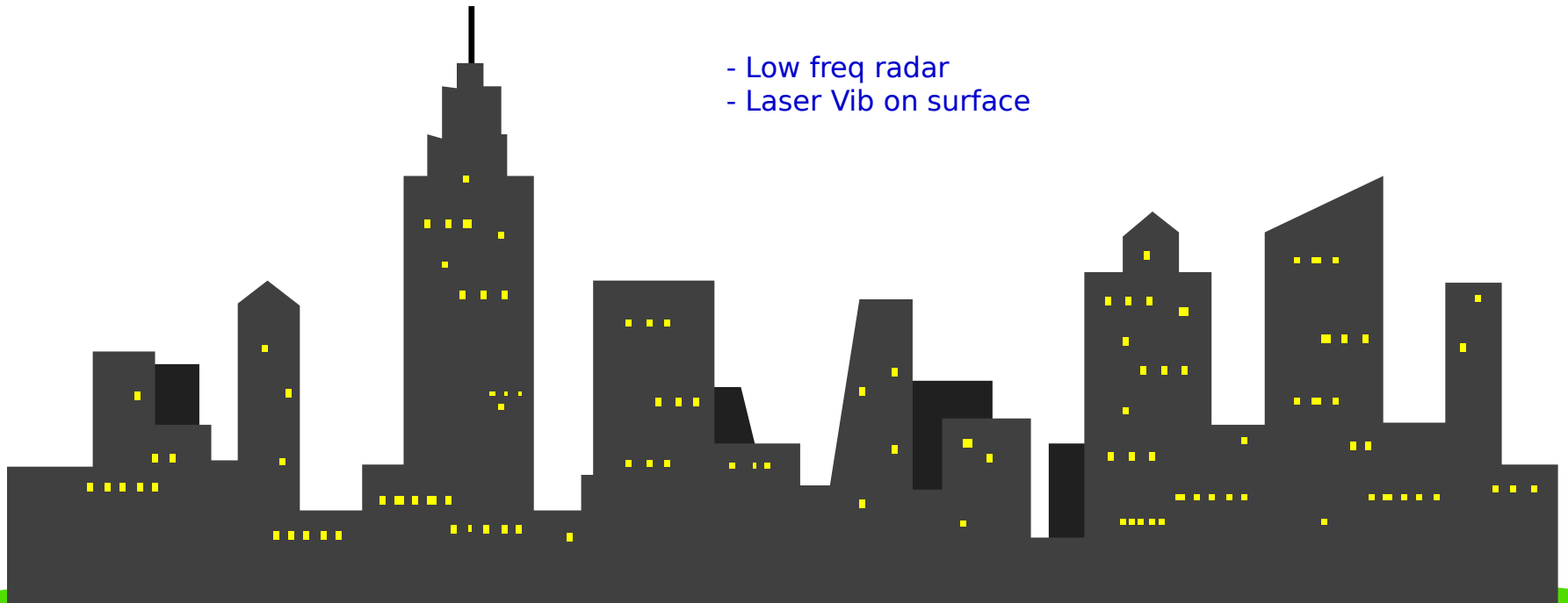




Sensing Inside of Buildings, & Underground



- Low freq radar
- Laser Vib on surface



Map underground Bunkers

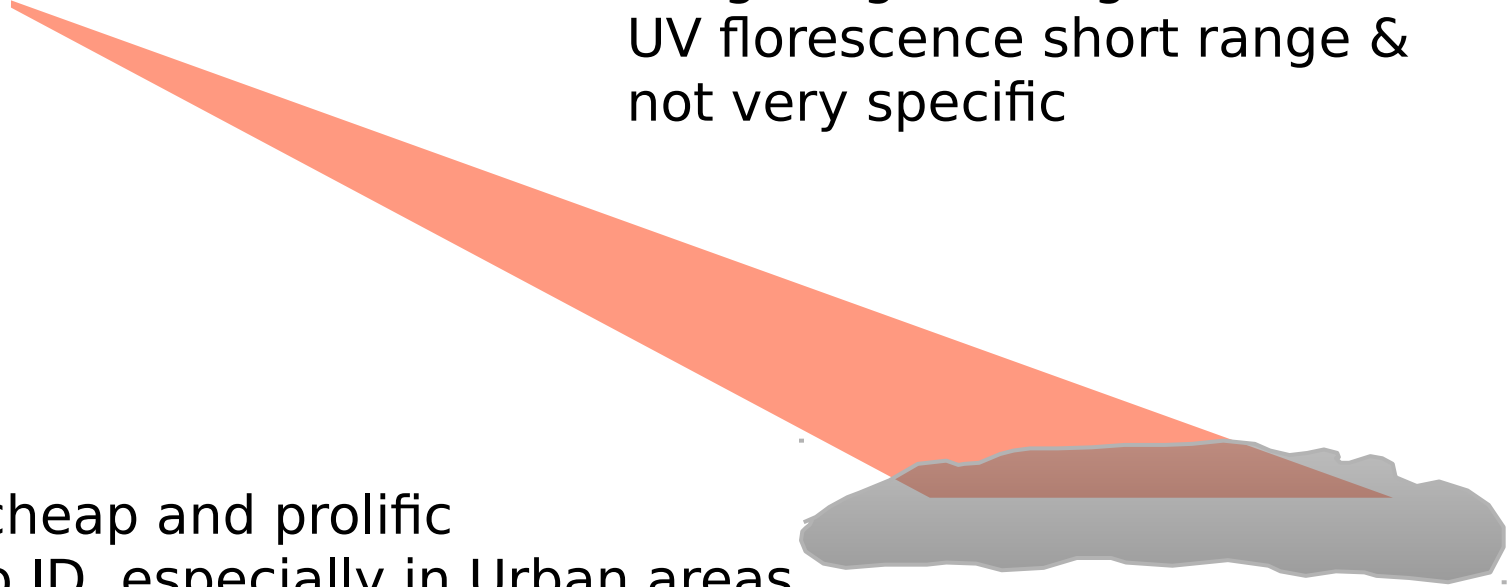
Bunker



Long Range Chem / bio ID



- Hundreds of Kilometers
- Precise chemical and Bio ID
- Lasers in the Mid IR can do Chem - but
Not at very long range
- Bio at long range is tough
UV florescence short range &
not very specific



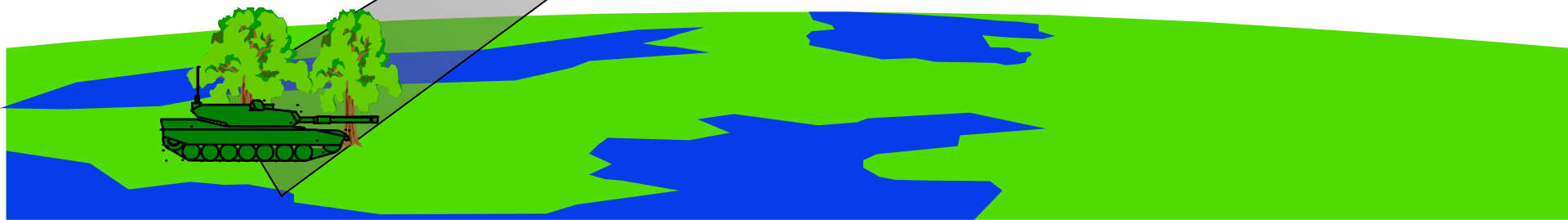
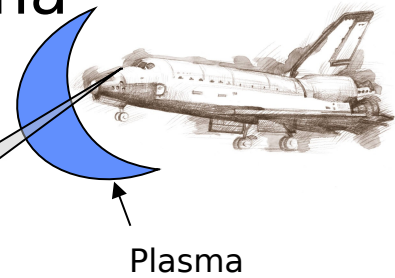
Also want cheap and prolific
Chem & bio ID, especially in Urban areas



Precise Sensors for Hypersonic Vehicles



- Laser Radar or mmwave to penetrate Plasma
- Long range to match senario
- Search is a real Issue



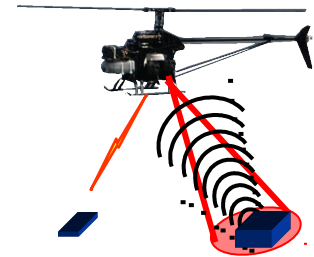


Sensor / Component Vision

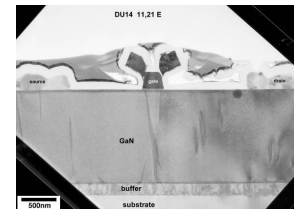


- **Affordable Sensors - Near zero touch labor**
- **Scalable sensors for application reuse & scaled performance**
- **Software Programmable Sensors**
- **Ultra-Low power consumption components / Sensors**
- **Miniature multi-function sensors for mini & micro sized platforms**
- **Harsh Environment tolerant Sensors (Thermal, electromagnetic, radiation, EMP)**
- **Anti-tamper components**
- **Safe use of commercial devices made in China, India, or elsewhere**
- **Better “physics of Failure” knowledge**

Small Close-In Sensors



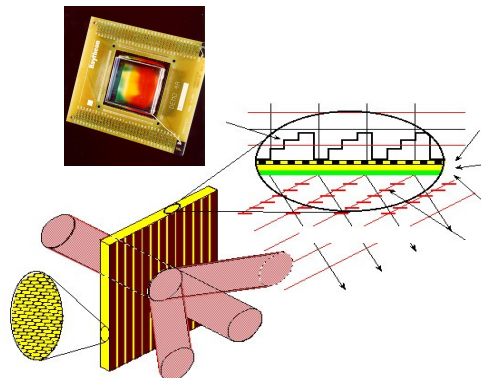
Device Properties / Physics of failure





Affordable Conformal Apertures

- **Rapid Random Access**
- **Sensing, countermeasures, and communications - requiring wideband**
- **Integration with receivers and transmitters**
- **Wide angle coverage**
- **Thin and repairable**



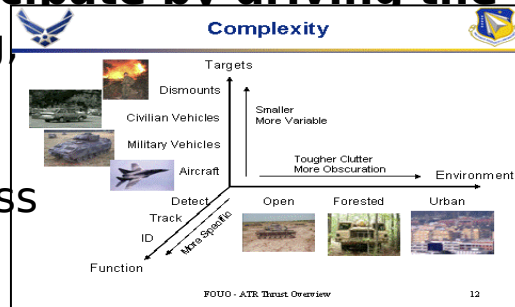


Anticipatory & Adaptable Automatic Target Recognition

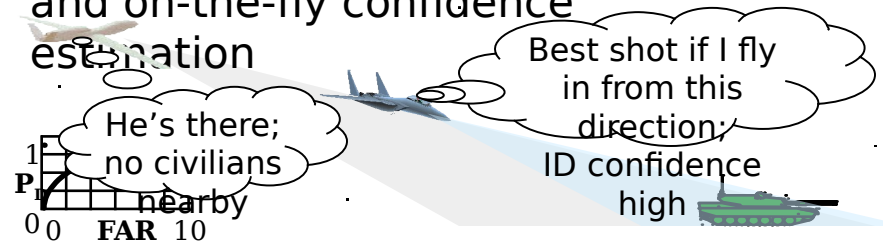


Anticipate by driving the enemy options

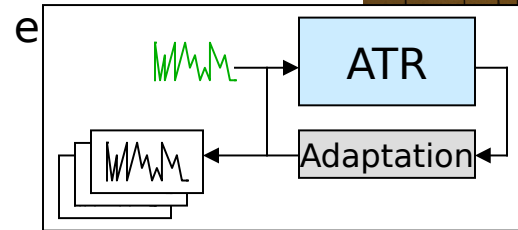
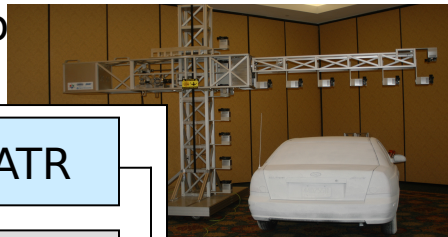
Detection, tracking, geolocation, and identification, and fingerprinting across targets and environments



A priori performance prediction and on-the-fly confidence estimation

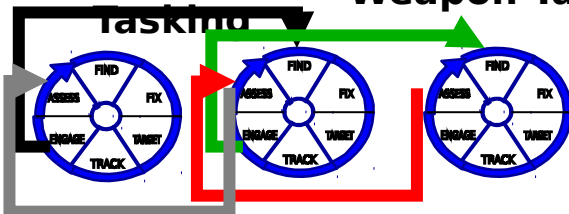


Rapid target acquisition and on-the-fly adaptation to targets and



Machine-to-machine horizontal and vertical integration

Strike Tasking Weapon Tasking

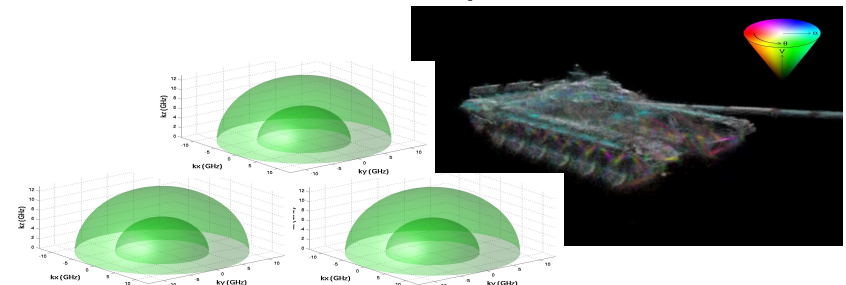


Strike Feedback Weapon Feedback

Forward and backward tracking for anticipation and analysis



ATR-driven sensor specification





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Summary Remarks



- **Layer Sensing is the way of the future**
 - High level, wide area search
 - Small, cheap vehicles and Sensors for close in.
 - Sensors web - Connected sensors everywhere
- **We are moving toward continuous sensing**
 - Change detection is powerful
 - Orders of magnitude lower false alarms
- **AFRL is moving to cross directorate planning**
 - Focused Long term Challenges will be a significant future part of AFRL
- **We need near zero touch labor for defense systems in the “World is Flat” World**
 - Required for us to afford the most technically advanced military in the world
- **Expect AFRL, to intensify their activity associated with counter-terrorism, counter-CBRNE and the GWOT**

Measure of Success: No Sanctuary for the Enemy





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